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The weather forecasting requirements of specific types of agriculture and horticulture.

W H HOGG

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Any comments or suggestions on this paper should be sent to the author.

Meteorological Office
ADAS
Burghill Road
Westbury on Trym
Bristol BS10 6NJ

April 1971

FGS
Stock 34

THE WEATHER FORECASTING REQUIREMENTS OF SPECIFIC TYPES OF AGRICULTURE AND HORTICULTURE

W H Hogg, Meteorological Office, Bristol

Introduction

The object of this paper is to assess the extent to which weather forecasts are used by the farming community, how they are used, the ways in which they could be improved and the demand for other types of forecast. The assessments are based on the answers to questionnaires distributed to selected farmers in Wales and the South West and West Midland Regions of the Agricultural Development and Advisory Service. The sample is by no means random, as the County Agricultural Advisers selected farmers who were likely to reply. Within each county the selection covered as wide a range of different enterprises as possible but the large scale arable farming of eastern England is not represented, nor are the major horticultural areas of eastern and south-east England.

A copy of the questionnaire is given as Appendix I, somewhat modified to save space. As will be seen from the introduction, it is assumed that the forecasts are substantially accurate in order to concentrate on the question: "What does a farmer need from a weather forecast?" Without this assumption there is little doubt that the primary requirement would have been greater reliability.

The response to the questionnaire was good. Some 60% of the forms were returned. A few could not be used for various reasons and the final numbers used in the analysis were:

Fig.e(1) Response to questionnaire

Region	Circulated	Usable replies
South West	85	51 (60%)
West Midland	76	45 (59%)
Wales	126	70 (56%)
Total	287	166 (58%)

Daily forecasts, present use

The extent to which the existing 24-48 hr forecasts are used can be obtained from the answers to questions A18-A24.

These clearly show (A18) that a large majority of those questioned use forecasts in planning their work, often or regularly, with a marked emphasis

on the period April to September (A19), see Fig.e(2).

Fig.e(2) Percentage of farmers using forecasts: Regularly (R), Often (O), Seldom (S) and Never (N) and percentage of entries for winter (O-M) and summer (A-S) half years

	R	O	S	N	O-M	A-S
South West	57	39	2	2	28	72
West Midlands	62	33	5	0	25	75
Wales	39	49	11	1	20	80
Total	50	42	7	1	24	76

The forecasts for the winter half year are often needed for work which is not urgent, cultivations and muck spreading are good examples, but specialists such as vegetable growers in the early areas of the South West use forecasts in relation to harvest and sheep farmers may be vitally concerned at lambing. Most of the interest in summer forecasts relates to harvests and conservation including silage-making but certain other operations such as spraying are also highly weather-dependent.

Radio and television forecasts are by far the most used by farmers (with little difference between them) and these are followed by forecasts obtained by telephoning a Meteorological Office (A20). Little use is made of forecasts in the press or recorded forecasts and an analysis of preferred times showed a marked wish for forecasts around breakfast-time, lunch-time, early evening and late evening (A21).

Fig.e(3) Forecasts used and preferred times

	Types					Times				
	TV	R	N	R(T)	F(T)	B	L	E_1	E_2	X
	per cent									
South West	32	43	4	6	15	36	17	13	20	14
West Midlands	36	41	1	3	19	37	19	13	15	16
Wales	47	33	7	1	12	30	22	10	23	15
Total	39	39	4	3	15	34	19	12	20	15

Note: The headings for the types of forecast are abbreviations of the items in question A20. The headings for the times are: B, Breakfast, 0630-0825; L, Lunch, 1230-1325; E_1, Early evening, 1730-1825; E_2 Late evening, 2030-2225; X, all other times.

The percentages are based on the number of preferences expressed and not on the number of usable returns.

Exactly 50% of the Welsh farmers stated that they telephone a Forecast Office, compared with 84% for the West Midlands and 76% for the South West. This regional difference is no doubt due to the greater distances and costs in Wales, with perhaps a feeling that a forecast made at a distance will not be sufficiently accurate for decisions on a particular farm (A22).

These forecasts are used mainly during May-September (80-90%, according to region). They are used for a wide range of farming activities - particularly for the spraying, conservation and harvest of a wide range of crops eg strawberry picking, hop picking and herbage seed harvest. In winter, the harvest of such crops as leeks and brussels sprouts can be affected by weather and lambing was mentioned as another reason for using forecasts in winter (A23).

When using general forecasts, well over 75% of farmers attempt to modify them on their own local knowledge and experience (A24). Farmers are about equally divided on the question of including references to farm operations in weather forecasts (A25) - a large majority in Wales favours this but a large majority in the West Midlands is against.

In questions A1 to A13, farmers were asked to state whether individual elements were important to them. The percentages of affirmative answers are given in the first 4 lines of Fig.e(4), based on the numbers of usable replies, see Fig.e(1). The reasons for which the information was likely to be used is given in the bulk of the same Fig.e(4), each mention of the particular farm operation being given a score of 1. Information on sunshine and rainfall amount is wanted by the largest number of farmers, mainly in relation to silage-making, hay-making and the cereal harvest. Rainfall is also useful in relation to a number of other operations, particularly cultivation and ploughing; drilling, sowing and planting; fertilizer application; spraying; and stock management. Frost figures high, for obvious reasons, followed by general windiness, a major factor in spraying, hay-making and the cereal harvest. The importance of snowfall is emphasized by stockmen and shepherds and, less frequently, by dairy farmers who must get their milk to collecting points. Only four elements were considered unimportant by the majority of farmers, night temperatures and frozen ground (perhaps because they are largely satisfied by the information on frost), hailstorms, apparently the least important and gales as opposed to general windiness, though this showed up as important in relation to any building construction and maintenance.

Fig.e(4) Importance of elements (per cent) and the associated farm operations (frequency)

	Elements, see Appendix												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
Regions	per cent												
SW	65	59	47	71	45	84	92	69	73	24	76	49	73
WM	62	64	47	82	36	82	80	56	53	18	69	31	69
Wales	61	44	37	67	31	83	76	46	70	14	63	57	46
All	63	54	43	72	37	83	82	55	66	18	69	48	60
Operations	frequency												
CP	4			9	22	2	12	6	2		2		2
D	16	6	3	12	5	4	23	11	2	1	10	2	1
FA	19	3	1	3	5	4	10	5	1		12	4	4
S	21	14	5	3		5	15	9		1	63	11	14
I		1				1	7	1			1		
Sil	7	8				29	26	11			9	2	8
HM	28	31	3			98	54	26		1	31	6	47
CH	21	15	1			62	39	25		3	23	13	34
RH	5	2		7		2	5	1			1		1
HSH	3	2				1				1	2	1	3
VH	2	1	2	5	1	2	2	1	3		1		1
FrH	3	2				1	2					5	1
FlH		1	1	1	1	1	2	1	1		1		1
CD		2	3										20
CS	3		9	16									6
SM	27	22	21	19	5	2	20	14	63	3	2	10	4
H	2	2	4	3							1		2
FP				38	1								
FC				16									
GM	3	2	4	3		3		2	1	2		1	1
BCM				3								18	
T				3	20		3		28				
DW					1		2	1					
HC					1				1		1	1	
GPR									1	1	1	2	
HW	1	1	1	1			1	1		1	1	1	
M	1								1				

Key: CP Cultivation and ploughing: D Drilling, sowing and planting: FA Fertilizer application: S Spraying: I Irrigation: Sil Silage-making: HM Hay-making: CH Cereal harvest: RH Root harvest: HSH Herbage seed harvest: VH Vegetable harvest: FrH Fruit harvest: FlH Flower harvest: CD Crop drying: CS Crop storage: SM Stock management: H Housing of animals: FP Frost protection (pipes): FC Frost protection (crops): GM Glasshouse management: BCM Building construction and maintenance: T Transport: DW Drainage work: HC Hedge cutting: GPR Glasshouse protection and repairs: HW Hop harvest and maintenance: M Marketing.

Questions were asked on combinations of elements, and wind frequently appears here. The two most important combinations are wind and rain, wind and sunshine (A14, A15). Wind and rain affects the management of stock and a number of operations such as spraying, silage and hay-making and combining; sunshine combined with wind (perhaps air movement would be a better term here) favours hay-making, corn drying and spraying, though calm weather is best for the actual spraying with some breeze later to dry the applied spray. Snow drifting produces many complications for the hill farmers concerned largely with livestock and they are alert to forecasts of wind and snow. The only treble combination mentioned is temperature, sunshine and humidity, in relation to hay-making. For many of the operations mentioned above the farmers are primarily interested in the 'drying power' of the air.

Only 25% of the farmers thought other elements were important, the two most frequently mentioned were soil temperature and visibility (A16, A17). The mention of visibility was a little surprising, though clearly the movement of stock could be affected, and also ploughing and drilling.

Daily forecasts, satisfaction and shortcomings

Questions A26-33 deal broadly with the satisfaction with the present forecasts, again excluding the factor of accuracy. The answers for these are summarized in Fig.e(5), with further notes below.

Fig.e(5) Percentage of affirmative answers to selected questions

	A26	A27	A28	A29	A31
South West	92	43	57	80	88
West Midlands	98	40	47	69	87
Wales	93	50	59	76	80
Total	94	45	55	75	84

There is a great demand for information on the probability of rainfall (A26). Opinion is about equally divided on the detail provided in TV (A27) and radio (A28) broadcasts although a considerable majority of farmers think there are enough TV (A29) and radio (A31) broadcasts. For TV, the most favoured times for additional forecasts were: 0630-0825, 1230-1325, 1730-1825 and 2030-2225, see also Fig.e(3). For many farmers the lunch-time forecast is rather too late except on Saturdays when it is brought forward, too much for some farmers. The request for additional

forecasts at 1730-1825 is surprising in view of the present timing.

Daily forecasts, general comments

In question A33 farmers were asked for additional comments which would help to explain what they think forecasts should contain. It is not possible to summarize these on a numerical basis and the following notes indicate the points which were most frequently mentioned.

1. The need for more local forecasts. The difficulty of providing these was understood by most farmers, some of whom suggested that they should be broadcast by local radio stations. Perhaps the most ambitious suggestion was for hourly forecasts.

2. The importance of Atlantic charts on TV was stressed and some farmers asked that information on the movement of systems should be given as fully as possible, clearly so that they could make some estimates of their own.

3. The importance of the individual weather elements has been dealt with earlier, but many farmers emphasized rainfall. If this can be more accurately forecast (timing, duration and intensity) a large range of farming operations could be more efficiently undertaken. With hay-making and harvesting in mind, a number of farmers asked for more information on drying weather.

4. It is clearly important for us to accept that many farm operations are spread over several days and that the outlook should be as long as possible, even though vague at the end. Certainly some obviously successful farmers are prepared to accept this as a basis for general planning, subject to a check with the nearest forecast office in relation to individual decisions.

5. Some points were raised which are not related to the technical content of a forecast but to difficulties in following the presentation. These included the lack of understanding of the meaning of weather symbols on TV charts and uncertainty as to location.

Weekly forecasts

The only guidance at present given on a weekly basis is contained in the BBC Farming Programme on Sundays. The questionnaire did not specifically deal with this, although some farmers commented on it. Over 90% of farmers

thought that weekly forecasts would help them (B1) and the elements on which information is most required (B2) are, in descending order, rainfall, sunshine, temperature, humidity, snow, wind and hail. The farming operations affected are similar to those mentioned earlier in relation to short term forecasts: the importance of rainfall throughout the year was emphasized in many replies.

Two main points emerged from the answers to question B3 which asked for further remarks on the possible uses of weekly forecasts in farming. The first of these was the acceptance of their value for planning. The second was the interest in the weather prospects for farmers and growers which is included in the Sunday Farming Programme on BBC TV. A few of the replies expressed some doubt as to their value, but far more commented favourably on them, often suggesting that they should be revised at least once during the week.

Monthly forecasts

The monthly weather prospects which are now issued twice monthly are seen or heard by 73% of farmers (C3) but only 31% make any use of them in their farming (C4). Not many more, 36%, thought that they would be helped by the inclusion of other weather elements (C1). Apart from temperature and rainfall, already included in the monthly weather prospects, there is substantial demand for sunshine and humidity (C2).

Farmers who use the present information cite 10 different farm operations in which it is applied (C5). Of the 52 farmers using it, 13 mention hay-making, 7 drilling, sowing and planting, 6 cereal harvesting, 5 each silage-making and stock management. Others mentioned less frequently are cultivation and ploughing, fertilizer application, spraying, root harvesting and transport.

If the monthly weather prospects were more accurate 81% consider that they would be an aid in farming (C6). Although the term precision was not used in the question, there may be some confusion between precision and accuracy. Fifteen operations are thought likely to benefit from 'improved' monthly forecasts and of these the five most frequently mentioned are: hay-making; cereal harvesting; stock management; drilling, planting and sowing; and silage-making (C7).

Question C8 asked for ways in which accurate but general forecasts could

help the farmer and, as with the weekly forecasts, the importance of planning was emphasized. A few farmers emphasized that shorter term forecasts up to about a week were more important to them. The importance of monthly forecasts in relation to grassland management is evident. In autumn a more open season will allow the stock to be kept out longer; in spring information on rainfall could lead to the saving of 2 weeks' winter feed by the application of fertilizer and controlled grazing.

The arable farmer is probably most interested in the timing of cultivation and drilling. He wants to know when he can safely get on to the land and the generalized monthly forecast should be sufficiently accurate for this - it should enable him to make his own estimates of the soil moisture status and soil temperature a few weeks ahead.

Forecasts needed for specific types of farming

To complete this summary of the survey, a few of the 166 usable replies have been selected and are described in some detail to indicate the forecast requirements for different types of farming. These cannot cover the whole range of agriculture and horticulture but are suggestive of the general needs in the western districts of England and in Wales.

Livestock farm

This is a farm of some 500 acres in Cardiganshire where fat lamb production and store cattle production are the main enterprises. The farmer uses radio forecasts in planning his work, he finds there are enough of these but would like more local forecasts; he does not live near a Forecast Office.

The main uses of daily weather forecasts to this farmer are given below.

Weather element	Period	Farm operation
General temperature	Jan-mid Mar.	Supplementary feeding of sheep, especially in relation to snow cover.
	late Feb-Mar.	Fertilizer application must be timed to anticipate soil temperature for grass growth.
Day temperature	June-Sept.	Hay and corn harvest (drying) (sunshine and humidity also relevant here).
Night temperature	Nov-Dec.	Cattle housing.
Frost		Freezing of water supplies to stock.
Frozen ground	Feb-Mar.	Ploughing and cultivation.
Rainfall		Amount affects stock housing. Intensity affects shearing.
Snowfall		Disruption of communications and transport affects shepherding and the outdoor feeding of stock.
Gales		General damage, including buildings.
Fog		Stock management in open areas.
Rain) Cold weather)	Winter	Stock housing.
Wind) Snow)	Winter	Blizzards - stock management.

This farmer would like weekly forecasts (he has no TV and does not see the Sunday Farming Programme) and thinks he would use them for most of his farm operations eg for cultivations and harvesting in the spring and summer and for stock management in winter. The present monthly weather prospects are of more interest than value to him but if they were more reliable he envisages he could use them for timing fertilizer applications and for rationing and housing his stock.

Milk production

This Somerset farm covers about 150 acres and the main enterprises are the production of milk and the rearing of dairy herd replacements. The farmer regularly uses radio forecasts, but never telephones a Forecast Office -

the area in which he farms is not well served in this respect. He thinks there are sufficient TV and radio forecasts but asks for more local details on the radio.

This farmer is interested in the daily forecasts for the following reasons.

Weather element	Period	Farm operation
General temperature	Mar-Oct.	Control of grazing, particularly when cattle are put out in spring.
Night temperature	Feb-May	Rearing of young calves, control of ventilation.
Frost	Nov-Mar.	Anti-freeze precautions in relation to machine milking and drinking troughs.
Frozen ground	Dec-Feb.	Manure spreading - provides opportunity to reduce accumulation during housing period.
Sunshine	May-Aug.	Hay and silage-making, rapid wilting and drying.
Rainfall amount	May-Aug.	Silage and hay-making, control of cutting policy.
	Mar-Oct.	Grazing management, minimizing poaching especially on newly sown leys.
	Mar-Sept.	Fertilizer application.
Rainfall intensity	Mar-Oct.	Flooding of Somerset Levels.
Snowfall	Mar-Apr.	Decisions on cattle housing
Humidity	May-Aug.	Silage and hay-making
Wind) Rain) Temperature)	Mar-Apr.	Grazing. If severe weather predicted, management modified to offer protection.

He would welcome weekly forecasts especially during the silage and hay-making season. This also applies to accurate monthly forecasts, which he would also use for more economical use of fertilizer for early grazing.

Arable farms

Replies were received from some largely arable farms in the east of the area under discussion. In order to cover a fairly wide range of crops the uses to which forecasts are put have been combined for 6 farms in Gloucestershire, Wiltshire and Worcestershire. These are each 600-900 acres and the crops include cereals, grass seed, beet seed, peas, beans and potatoes. The main uses are as follows:

Weather element	Period	Farm operation
General temperature, day and night	July-Sept.	Harvest, herbage seed and cereals.
	Aug-Jan.	Harvest, potatoes and beet.
	Mar-May	Fertilizer application.
	April-May	Drilling and spraying.
Frost	Winter	Potato lifting. Cultivations. Potato storage (clamp protection).
Frozen ground	Winter	Ploughing and cultivation.
Sunshine	Mar-Nov.	Bed preparation. Harvesting.
Rainfall		All land work.
	June-Aug.	Cereal and grass seed harvest.
Snowfall		All land work. Access.
General windiness		Drying at harvest (with sun).
	Mar-Nov.	Broadcasting, spraying, harvesting (also, gales).
Humidity	July-Sept.	Harvest, cereals and herbage seed.
	Autumn	Grain drying in store.
		Potato blight spraying.
Snow and wind		Access.
Sun and wind	June-Sept.	Drying standing corn; harvesting in general.

All of these farmers think that weekly forecasts would help them, mainly in relation to fertilizer application, drilling, spraying and harvesting. The same general views were expressed in relation to monthly forecasts.

Horticulture

Horticultural enterprises may be very specialized. One grower may

concentrate on tomatoes and chrysanthemums under glass, another on top fruit and a third on salad vegetables; their interest in forecasts will therefore vary considerably. In the area investigated, horticulture is not widespread and no attempt has been made to cover the whole field. As an example, details are given from a grower in Worcestershire with some 70 acres of apples, pears, plums and gooseberries and some additional land for vegetable production.

This grower is no doubt able to read more into forecasts than most people as he had some meteorological training. He regularly uses forecasts, both TV and radio, and telephones the local Forecast Office at any time of the year - in spring and summer when spraying and drilling, and in autumn and winter when frost may interfere with the harvesting of sprouts and leeks. He is satisfied that the present TV and radio forecasts are as frequent and as detailed as can be expected and that more local forecasts can be provided only by local radio stations.

Weather element	Period	Farm operation
Day temperature	June-July	Spraying top fruit. Knowledge of high temperatures important.
Frost	Dec-Mar.	Vegetable harvest. Helps to determine time of starting work next day.
Frozen ground	Winter	Draining water from vegetable washing machines and supply pipes.
Rainfall	Mar-Aug.	Irrigation. Spraying. Cultivations.
Wind	Mar-Aug.	Spraying

He is very doubtful whether weekly or monthly forecasts would help him. This is interesting and against the general opinion expressed in the replies. Perhaps he has less need to get on to his fruit land early in the year, finds drilling and cultivation unnecessary and can use chemical means of weed control.

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QUESTIONNAIRE TO SELECTED FARMERS AND GROWERS

Introduction

Many farmers use weather forecasts as an aid to management especially at certain times of the year, for example at hay-making or harvesting. The first requirement of a forecast is that it shall be substantially correct. Another important requirement is that the farmer is given the information which is most likely to be useful to him. In this survey we are assuming that the forecasts are accurate, in order to concentrate on the question: "What does a farmer need from a weather forecast?". Nobody is better able to answer this question than the farmer himself and this is why we are seeking your co-operation.

The questionnaire is arranged in groups according to the type of forecast. In each of these groups there are a number of questions to be briefly answered. We fully realize that it may not be easy to express some aspects of your requirements by answering these questions and we would welcome additional remarks.

GROUP A 24-48 hr FORECASTS Questions A1-A33

The normal forecasts now issued cover a period up to 24 hours with an outlook for another 24 hours, sometimes longer. As we wish to find out what you want from forecasts, your entries will deal with the ways you use forecasts and the ways in which you would like to use them if they were more detailed or contained other information.

WEATHER ELEMENTS Questions A1-A13

The list in col.1 contains the elements most likely to be mentioned in a forecast. For each one of these please decide whether it is important for you to know about it in advance. If so, please tick in col.2 (headed Yes): if not, please tick in col.3 (headed No).

If the answer is Yes please continue along the line stating the farming operation the weather could affect and the months during which it is important. Any weather element may affect more than one farming operation and there may be several entries in columns 4 and 5 for one element.

1	2 Important Yes (tick in col.2 or col.3)	3 Important No	4 Farming operation	5 Months	6 Remarks

WEATHER ELEMENT

A 1 General temperature
A 2 Day temperature
A 3 Night temperature
A 4 Frost
A 5 Frozen ground
A 6 Sunshine
A 7 Rainfall amount
A 8 Rainfall intensity
A 9 Snowfall
A10 Hailstorms
A11 General windiness
A12 Gales
A13 Humidity of air

COMBINATIONS OF ELEMENTS Questions A14-A15

A14 Are any combinations of elements (for example, rain & wind) important? Yes/No

A15 If Yes, please list them with details: Combined elements; Farming operation; Months; Remarks

OTHER ELEMENTS Questions A16-A17

A16 Do you think any other elements not already mentioned are important? Yes/No

A17 If Yes, please list them with details: Other elements; Farming operation; Months; Remarks

GENERAL Questions A18-A33

A18 How much do you use forecasts in planning your work? Please tick one of these: Regularly; Often; Seldom; Never

A19 If regularly or often, please state months when they are more used and for what purposes:

A20 If you use forecasts at all, which do you use most? Please tick one of these: TV forecasts; Radio forecasts; Newspaper forecasts; Recorded forecasts (telephone); Forecast Office (telephone).

A21 At what times of day would you most like forecasts to be broadcast? Please give the time (or times) to the nearest hour eg 7 am, 1 pm, 7 pm

A22 Do you ever telephone a Forecast Office? Yes/No

A23 If Yes, please state when (months) and why (farming operation):

A24 Do you make any attempt to modify the general forecast by your local knowledge and experience? Yes/No

A25 Do you think that forecasts should include any references to the farming operations which may be affected by the weather which is forecast? Yes/No

A26 Would you like to have some indication of the probability of rain? Yes (probabilities useful) / No

Example: There is a 60% chance of rain to-day and 20% chance tomorrow.

A27 Do you consider that the present TV forecasts are sufficiently detailed? Yes/No

A28 Do you consider that the present radio forecasts are sufficiently detailed? Yes/No

A29 Do you think there are enough TV forecasts? Yes/No

A30 If not, at what hours would you like additional forecasts? Times:

A31 Do you think there are enough radio forecasts? Yes/No

A32 If not, at what hours would you like additional forecasts? Times:

A33 Additional comments: please add here any additional comments which will help to explain what you think forecasts should contain.

GROUP B WEEKLY FORECASTS Questions B1-B3

B 1 If weekly forecasts were available do you think they would help in your farming? Yes/No

B 2 If Yes, which elements of the following would be most important, and how and when? Temperature; Sunshine; Rainfall; Snow; Hail; Humidity of air.

B 3 Additional comments: please add here any further remarks you would care to make on the possible uses of weekly forecasts in farming.

GROUP C MONTHLY FORECASTS Questions C1-C8

Monthly weather prospects are issued at the beginning and middle of each month. These give in general terms the type of weather expected over about the following 4 weeks. They indicate whether the weather is expected to be warmer or cooler than average, and wetter or drier. The monthly weather prospects are published in the press and issued on TV and radio.

C 1 If monthly weather prospects included other elements, do you think they would help you in your farming? Yes/No